European Journal of Applied Sciences – Vol. 13, No. 06
Publication Date: November 27, 2025
DOI:10.14738/aivp.1306.19627.
Genoveva, Á. O. M., Díaz, E. A., Guerra, R. R., Ramírez, J. S. P., & León, I. H. A. (2025). Selection of Improved Native Avocado Varieties in Southern Nuevo León, Mexico. *European Journal of Applied Sciences, Vol - 13(06).* 77-83.

Selection of Improved Native Avocado Varieties in Southern Nuevo León, Mexico

Álvarez Ojeda María Genoveva
INIFAP-CIRNE-Río Bravo Experimental Station,
Km 61 Matamoros-Reynosa Highway, C.P. 88900,
Río Bravo, Tamaulipas, México

Efraín Acosta Díaz
INIFAP-CIRNE-General Terán Experimental Station,
Km 31 Montemorelos-China Highway, C.P. 67400,
General Terán, Nuevo León, México

Raúl Rodríguez Guerra
INIFAP-CIRNE-General Terán Experimental Station,
Km 31 Montemorelos-China Highway, C.P. 67400,
General Terán, Nuevo León, México

José Saúl Padilla Ramírez
INIFAP-CIRNOC-Pabellón Experimental Station,
Km 32.5 Aguascalientes-Zacatecas Highway, C.P. 20660,
Pabellón de Arteaga, Aguascalientes, México

Isidro Humberto Almeyda León*
INIFAP-CIRNE-General Terán Experimental Station,
Km 31 Montemorelos-China Highway, C.P. 67400,
General Terán, Nuevo León, México
*Corresponding author: halmeyda30@hotmail.com

ABSTRACT

Given the importance of avocado cultivation in Mexico, several studies have been conducted to understand and evaluate the genetic and morphological variability, as well as the total oil content and fatty acid profile of different genotypes, particularly of native avocados from various regions of the country. Recently, a group of outstanding materials were identified as potential bud donors, and one variety was selected as a possible rootstock in the state of Nuevo León. Based on this, the objective of this study was to select the most outstanding improved native avocado varieties based on the phenological, morphological, and chemical characteristics of the fruit. A group of 10 outstanding genotypes was used, derived from an initial batch of 29 materials collected in the southern region of the state of Nuevo León. A commercial "Hass" variety was also included. Six ripe fruits were sampled from each variety and evaluated, and their phenological, morphological, and chemical characteristics were determined. Based on the results, the improved native varieties María Elena, Plátano Grueso, Mantequilla, and Calabo were selected, given

that they exhibited outstanding phenological, morphological, and chemical characteristics. These varieties represent a viable alternative for the sustainable and phased production of native avocados through an organized orchard planting system in the southern region of the state of Nuevo León.

Keywords: Morphological characteristics, harvest season, oil content.

INTRODUCTION

The avocado originated in central and eastern Mexico, as well as the highlands of Guatemala. Both regions are included in what is known as Mesoamerica and is also considered the area where the domestication of this crop took place (Williams, 1977a). The botanical classification of these three races has varied. Some classify the Mexican race as a separate species, *Persea drymifolia* (Kopp, 1966), while others, such as Williams (1977b), classified the Guatemalan race as *Persea nubigena* var. *guatemalensis*. However, currently, three avocado races are recognized: the Mexican race (*Persea americana* var. *drymifolia*), the Guatemalan race (*Persea americana* var. *guatemaltensis*), and the Antillean race (*Persea americana* var. *americana*). The Mexican race includes native varieties, known by local names, whose fruit is consumed and traded locally and is cultivated in most Mexican states (Barrientos-Priego and López-López, 2002). The oldest evidence of avocado consumption was found in a cave in Coxcatlán, in the Tehuacán region of Puebla, Mexico, dating from 8000-7000 BC (Smith, 1966). According to the background, we can say that the history of the avocado in Mexico began in pre-Columbian Mexico, where avocado fruit was already being selected to obtain larger fruit with smaller seeds. However, after the discovery of America, it remained largely unknown until the late 19th century, when the introduction of the Fuerte variety to California in 1911, using material from Atlixco, Puebla, Mexico, marked the expansion of the first avocado production industry (Bergh, 1992). The southern region of Nuevo León is also part of the primary center of origin for *P. americana* var. *drymifolia*, where the native varieties used have been selected by producers based on their yield, quality, and fruit size. These are grafted cultivars with genotypes of interest and are called "Improved Creole Varieties" (Acosta *et al*., 2012). Global avocado production in 2020 was estimated at 4.1 million tons, with the main producing countries being Mexico, United States, Indonesia, and Chile (FAO, 2020). In 2024, the planted area reported was 264,589 ha, with a production of 2,973,344 t and an average yield of 11.73 t ha^{-1}. The states that stand out for their production are: Michoacán with 2,252,783 t, followed by Jalisco with 323,228 t and State of Mexico with 132,478 t. (Guillén, 2025). The state of Michoacán is the national leader in both production and exports, contributing approximately 95% of the total volume of harvested fruit (SIAP, 2020). Due to its export volume, Mexico ranks as the world's leading avocado exporter, accounting for 42.5% of global avocado exports in 2020, according to FAOSTAT (2021). Avocado exports to the global market face the problem of limited market diversification, since in 2020, 77% of Mexico's total avocado exports were concentrated in the United States, with Canada and Japan as the second and third largest destinations, accounting for 6.81% and 5.30% respectively. (SIAVI, 2021). Avocado consumption is highly significant in Mexico, with an estimated annual per capita consumption of 8 kg per person in 2019 (Statista, 2022). Given the importance of this crop in Mexico, a collaborative project on native avocado varieties was developed in the state of Nuevo León in 2008 between the National Institute of Forestry, Agricultural and Livestock Research and the Nuevo León Produce Foundation. In this project, the genetic diversity of the germplasm present in the southern region was determined

at the first stages (Acosta-Díaz *et al.,* 2012). Subsequently, the variability in total oil content and fatty acid profile was evaluated (Acosta-Díaz *et al*., 2019), and more recently, a group of 10 outstanding materials was identified as potential donors of plant buds, along with one variety as a possible source of rootstocks (Acosta-Díaz *et al*., 2022). The objective of this study was to select the most outstanding improved native avocado varieties based on the phenological, morphological, and chemical characteristics of the fruit in the southern region of the state of Nuevo León.

MATERIALS AND METHODS

The research was conducted in three commercial native avocado orchards in the municipalities of Aramberri and Zaragoza, Nuevo León (27° 49' N latitude, 98° 26' W longitude, and 1,160 masl). The orchards are family-run, employing traditional, low-input agricultural technologies under flood irrigation.

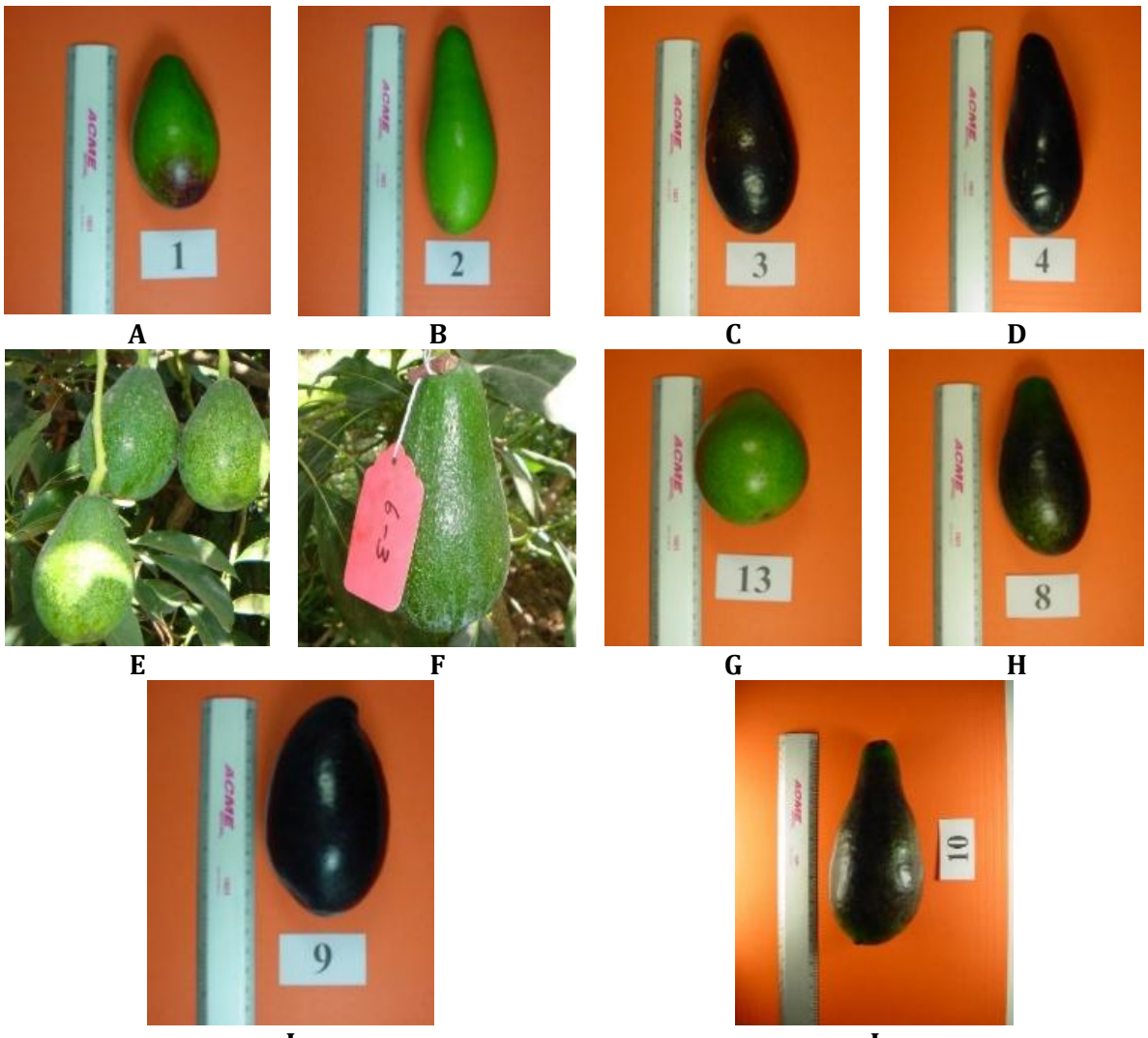


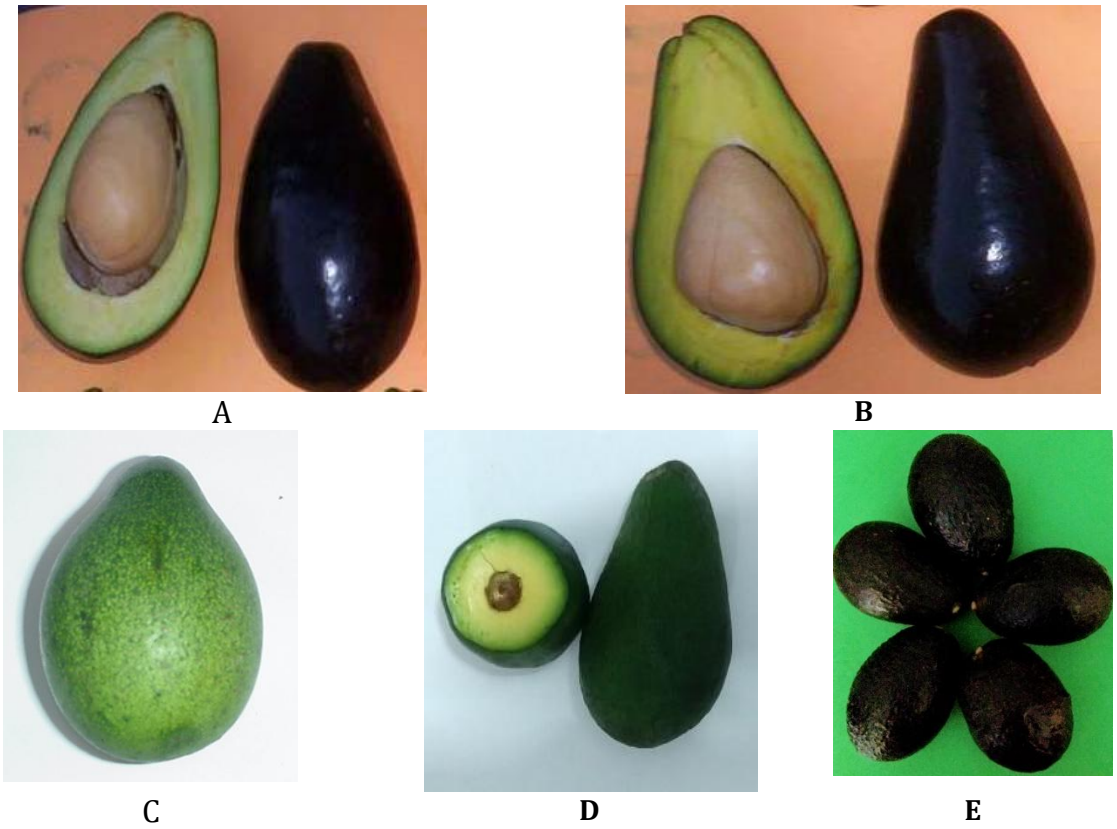
Figure 1. Native avocado varieties from Nuevo León, México. A: Plátano grueso, B: Plátano grueso-1, C: María Elena, D: Campeón, E: Mantequilla, F: Calabo, G: Huevo de paloma, H: Todo el año, I: Criollo 1, J: Huevo de toro.

A group of 10 materials (Figure 1) outstanding for their phenological, morphological and chemical characteristics was used (Acosta-Díaz *et al*., 2022), which come from an initial batch of 29 materials selected in the southern region of Nuevo León (Acosta-Díaz *et al*., 2012), a commercial variety of the "Hass" type was also included. Six ripe fruits were sampled from each variety and the following characteristics were determined: Production availability, fruit shape, ripening skin color, skin appearance, fruit weight, seed weight, and total oil content. Fruit shape and skin color were determined visually in ripe fruit. Fruit and seed weight were determined using a scale accurate to the nearest gram. Total oil content was determined using method 920.85 described by the Association of Official Analytical Chemists (AOAC, 2016).

RESULTS AND DISCUSSION

Of the 10 avocado materials initially used in this study (Figure 1), four improved landrace varieties, as well as the commercial "Hass" type variety, were selected as the best possible alternatives to expand the commercial supply to the local and regional market (Figure 2). This selection was based on the outstanding phenological, morphological, and oil content characteristics of these materials in the southern region of the State of Nuevo León. The varieties were classified into five different groups according to fruit availability (Table 1). The first group is represented by the María Elena variety, with an earlier cycle (June 15 to July 15) and fruit ranging in skin color from purple to dark black. The second group consists of the Plátano Grueso variety, with an intermediate cycle (July 15 to August 15) and fruit also ranging in skin color from purple to dark black. These two improved landrace varieties can cover certain market niches, such as the gourmet variety, which produces only ready-to-eat avocados, including those with the endible skin. The third group included the Mantequilla variety, a late-season variety (October 15 to November 15) with bright green fruit. The fourth group consisted of the Calabo variety, also a late-season variety (November 15 to December 15) with dark green fruit. Finally, the fifth group was comprised of the improved "Hass" variety, a very late-season variety (December 15 to March 15) with dark brown to black fruit. The advantage of planting the improved "Hass" variety in orchards in southern Nuevo León is that, because it is harvested 12 weeks later than the improved local variety Calabo, it allows for a harvest during the months with the highest demand and best prices for the fruit in the local market.

Regarding fruit weight, three groups of materials were identified: one with high values, another with intermediate values, and another with low values (Table 1). The first group included two genotypes, Calabo and the improved "Hass" type variety. The former is an improved local variety, and the latter is a commercial variety, with fruit weights of 249 and 200 g, respectively. The second group consisted of an improved local variety, Plátano grueso, with a fruit weight of 146 g. The third group included two improved local varieties, María Elena and Mantequilla, with fruit weights of 88 and 81 g, respectively. Regarding total oil content, values ranged from 69.7% in the Plátano grueso variety to 60.8% in the Mantequilla variety. In general, the varieties were characterized by high oil content values; however, they can be grouped into three different categories: One with high values, comprising Plátano grueso and Calabo with values of 69.7% and 65.2% respectively; another group with intermediate values, made up of the improved "Hass" type variety and the improved native variety Mantequilla with values of 63.9% and 60.8% respectively; and another group with a relatively low value, consisting of the improved native variety María Elena with a value of 57.5% (Table 1).



A **B**

C **D** **E**

Figure 2: Fruits of five improved native avocado varieties selected in the southern region of the State of Nuevo León. A= María Elena, B= Plátano Grueso, C= Mantequilla, D= Calabo, E= Commercial variety "Hass".

The above results suggest that the five varieties selected in this work represent an alternative for establishment in future commercial orchards in the southern region of the State of Nuevo León, since the use of these genotypes would allow having varieties with different harvest periods (early, intermediate, late and super late), with fruits of different shape, skin color when ripe (black and green), different shape (oval and pear-shaped), fruit weight and with high total oil content, and with high adaptation to the climatic conditions of the southern region of the State of Nuevo León.

The María Elena and Plátano grueso varieties can fill certain market niches, such as gourmet varieties, whose characteristic is that they are avocados ready to eat, even with the skin on. These results are highly relevant today, since, as Guillén (2025) points out, the Hass variety began displacing native varieties and some improved varieties introduced, such as Fuerte, Bacon, and Zotano, are achieving remarkable expansion by becoming the most commercially important variety worldwide. The main production strategy has been the opening of new cultivation areas, with serious environmental consequences in the region where land use has changed. Over the past two decades, research efforts have focused on identifying avocado genotypes with characteristics similar to the Hass variety, but with attributes such as short stature, early maturity, and high productivity, among others. To date, approximately 12 genotypes have been identified that can compete with Hass; all of them have been evaluated for their morphology, chemical composition, and lipid profile (Guillén, 2025). The selection of

avocado genotypes with the aforementioned characteristics is of particular interest for the native avocado of the state of Nuevo León, whose short shelf life is a major commercial challenge. Therefore, leveraging the significant genetic variation identified by Gutiérrez-Díez *et al*. (2009), Gutiérrez-Díez *et al*. (2015), Álvarez *et al*. (2018), and Acosta-Díaz *et al*. (2020) increases the possibility of developing new varieties with a longer shelf life, thus increasing their commercial value. Furthermore, the existing characteristics of native avocados could be used to generate varieties with higher essential oil content than that found in commercial varieties such as Hass, a characteristic which was observed in some of the materials selected in this study.

Table 1: Phenological, morphological and chemical characteristics of outstanding improved native avocado varieties in the southern region of Nuevo León.

Variety Improved Creole	Availability	Fruit Shape	Peel Color at Ripeness	Fruit Weight (g)	Seed Weight (g)	Peel Appearance	Oil Content (%)
María Elena	15 jun-15 jul	Slightly oval	Purple to dark black	88	28	Smooth, soft, flexible	57.5
Plátano grueso	15 jul–5 aug	Slightly oval	Purple to dark black	146	40	Smooth, soft, flexible	69.7
Mantequilla	15 oct-15nov	Pear-shaped	Bright green	81	26	Smooth, soft, flexible	60.8
Calabo	15 nov-15 dec	Oval, slightly elongated	Dark green	249	40	Thin and smooth	65.2
Tipo “Hass”	15 dec-15 mar	Pear-shaped, slightly oval	Dark brown to black	200	37	Thick and rough	63.9

CONCLUSIONS

Four improved native varieties and one commercial variety were selected, all of which exhibited outstanding phenological, morphological, and chemical characteristics of the fruit. These materials represent a viable alternative for the sustainable and phased production of native avocados through an organized orchard planting system in the southern region of the state of Nuevo León.

ACKNOWLEDGMENTS

We thank the Nuevo León Produce Foundation for the funding provided for the project that gave rise to this work.

References

Acosta-Díaz, E., Hernández-Torres, I. and Almeyda-León, I.H. 2012. Evaluación de aguacates criollos en Nuevo León, México: Región sur Rev. Mex. Cien. Agr. 3:245-257. https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2007-09342012000200003.

Acosta-Díaz, E., Álvarez-Ojeda, M.G, Guzmán-Maldonado, S.H. and Almeyda-León, I.H. 2019. Variabilidad del contenido total de aceite y perfil de ácidos grasos de aguacates criollos de Nuevo León, México. Revista Agronomía Mesoamericana 30:705-719. doi: https://doi.org/10.15517/am.v30i3.34490.

Acosta-Díaz, E., Rodríguez-Guerra, R. and Almeyda-León, I.H. 2020. Variabilidad morfológica y genética del germoplasma de aguacate criollo en Nuevo León, México. Biotecnología y Sustentabilidad Vol. 5. Num. 1: 91-108. https://revistas.uaz.edu.mx/index.php/biotecnologiaysust/issue/view/95.

Acosta-Díaz, E., Álvarez-Ojeda, M.G., Ramos-Cruz, C.M., Padilla-Ramírez, J.S. and Almeyda-León, I.H. 2020. Characterization of Avocado Improved Creole Varieties of Nuevo León, México. Modern Environmental Science and Engineering. Volume 8, No. 5: 287-291. doi:10.15341/mese(2333-2581)/05.08.2022/005

Álvarez, O.M.G., Pecina, Q.V., Acosta, D.E. and Almeyda, L.I.H. 2018. Evaluación molecular del aguacate criollo (Persea americana Mill) en Nuevo León, México. Rev. Colomb. Biotecnol. Vol. XX No. 2: 38 – 46. doi:10.15446/rev.colomb.biote.v20n2.69551.

AOAC (Association of Official Analytical Chemists). 2016. Official methods of analysis of the Association of Official Analytical Chemists. 20th ed. AOAC, Rockville, USA.

Barrientos-Priego, A.F. y López-López L. 2002. Historia y Genética del Aguacate. In: Memoria de la Fundación 'Salvador' Sánchez Colín. Centro de Investigaciones Científicas y Tecnológicas del Aguacate en el Estado de México. pp. 100-121.

Bergh, B. 1992. The origin, nature and genetic improvement of the avocado. California Avocado society yearbook 76: 61-75. http://www.avocadosource.com › cas_1992_pg_061.

FAO. 2020. Las principales frutas tropicales. Análisis del mercado 2018. Roma. pp. 18.

FAOSTAT. 2021. Estadísticas de la Organización de las Naciones Unidas para la Agricultura y Alimentación. Datos de cultivos y productos de ganadería mundial aguacate año 2010-2020. Food and Agriculture Organization (FAO). Italia.

Guillén, A.E. 2025. El aguacate en Michoacán, México: Avances en la investigación de genotipos alternativos a la variedad Hass. XX Congreso Nacional y VI Congreso Internacional de Hortícultura, San Nicolás de los Garza, Nuevo León, México. Pag. II.

Gutiérrez-Díez, A., Martínez-De la Cerda, J., García-Zambrano, E.A., Iracheta-Donjuan, L., Ocampo-Morales, J.D. and Cerda-Hurtado I.M. 2009. Estudio de la diversidad genética del aguacate en Nuevo León, México. Revista Fitotecnia Mexicana 32(1): 9-18. https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0187-73802009000100002

Gutiérrez-Díez, A., Sánchez-González, A., Torres-Castillo, J.A., Cerda-Hurtado, I.M. and Ojeda-Zacarías, M. del C. 2015. Genetic Diversity of Mexican Avocado in Nuevo León, México. In: M. Caliskan et al., editors, Molecular Approaches to Genetic Diversity. InTech, MEX. p. 141-159. doi:10.5772/59795.

Kopp, L. E. 1966. A taxonomic revision of the genus Persea in the Western Hemisphere (Perseae-Lauraceae). Memoirs of the New York Botanical Garden 14(1): 1-120. https://floradecuba.org/cdm_dataportal/reference/85231b17.

SIAP. 2020. https://www.gob.mx/siap/acciones-y-programas/produccion-agricola-33119.

SIAVI. 2021. Sistema de Información Arancelaria Vía Internet. Estadísticas mensuales. Exportaciones mensuales de México por país de aguacate, año 2020. Ciudad de México, México. http://siavi.economia.gob.mx › siavi5r › estadisticas-men.

Statista. 2022. Statista Research Department. Consumo por persona de aguacate en México 2015-2019. Estados Unidos de América. Statista Research Department (Statista). https://es.statista.com/estadisticas/1263554/consumo-per-capita-de-aguacate-mexico/.

Smith, C.E. Jr. 1966. Archeological evidence for selection in avocado. Economic Botany 20: 169-175. file:///C:/Users/INIFAP-MOVIL/Downloads/BF02904012.pdf.

Williams, L.O. 1977a. The avocados, a synopsis of the genus Persea, subg. Persea. Economic Botany 31: 315-320. doi:10.1007/BF02866883.

Williams, L.O. 1977b. The botany of the avocado and its relatives. Proc. 1st international Tropical fruit Short Course, The Avocado. University of Florida, Gainesville, Florida. USA. pp.9-15.